User Manual
Vimpacct tool v1.0

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Chapter 1

Introduction

Welcome to Vimpacct v2.0, a mission-level energy simulator and analyzer. The name Vimpacct stands for Visual Integrated Management of Power Aware Computing and Communication Technologies. Vimpacct enables system-level *modeling*, *optimization*, and *validation* of complex power-aware embedded systems by offering:

- a generic power model for both digital and analog system components, and application models that capture the environmental knowledge and the application-specific scenarios.
- the capability to exploit mission-awareness in power saving, in addition to the well-known workload-driven schemes.
- the capability to run *in-situ* hardware/software co-simulation by sending the generated power commands to the hardware through CORBA interface.

Software Installation

Required Packages

Vimpacct is a cross-platform software written in Python; it runs on Linux/Unix, Mac OS, and Windows platforms without changing the code. For running the software with full functionality, the following packages are required:

- Python v2.2 or higher with Tkinter support
- omniORB v4.0 or higher and omniPRBpy v2.0 or higher
- SpecC compiler v1.2 or higher

However, without omniORB and SpecC packages, you can still partially run the tools. omniORB is used for the execution of power commands through CORBA interface while SpecC is used for re-compiling the power models for mission simulation. The rest of the user guide assumes the usage of full functionality and therefore you should have all packages installed.

Python is pre-installed on most Unix/Linux and Mac OS platforms. To check whether your python package has Tkinter support, first invoke a Python interpreter by opening the terminal (your system shell) and type

```
% python
```

Inside the interpreter, type

```
% Tkinter
```

Note that these commands are case sensitive. If no error message appears, then you have the Tkinter module installed. Similarly, to check whether you have omniORB installed, type

```
% from omniORB import CORBA
```

If these packages are not installed, you can download them at

- Python: http://www.python.org
- omniORB: http://omniorb.sourceforge.net/
- SpecC: http://www.ics.uci.edu/∼specc/

How to Install Vimpacct

Here are the quick download links for Vimpacct package:

- http://www.ece.uci.edu/impacct/software/vimpacct-1.0.tar.gz (for Linux/Unix/Mac OS)
- http://www.ece.uci.edu/impacct/software/vimpacct-1.0.zip (for Windows)

To unzip the package, Linux/Unix and Mac OS users can type one of the following commands in the terminal

```
% gunzip vimpacct-1.0.tar.gz | tar xvf -
```

```
% tar xzvf vimpacct-1.0.tar.gz
```

Windows users should use Winzip (http://www.winzip.com) or other third party software to unzip the package.

A root directory named **jtrs** is created on your host. In the rest of this user manual, we will use "$JTRS" to represent the path to the directory. You do not need to additionally set this path in the shell environment nor build/install the software, since the Python scripts are interpreted rather than pre-compiled. If you successfully unzipped the package, you are ready to go ahead to the next step.

Setting up the servers

To fully run the tools, you need to have two servers set up. One is the SpecC Simulation Server (SSS), the other is the CORBA Power Server (CPS).

You can set up each server either on local host, on a remote host. We recommend to set up the servers on remote hosts (either a Unix/linux machine or an Apple machine with Mac OS X). Let us name your local host "Host A" and the server host "Host B". To set up the servers on "Host B", you need to download and unzip the same software package on "Host B" as you did on "Host A". Run the following command on the terminal of "Host B" to start the SSS:

```
% cd $JTRS/daemon
```

```
% python sc_daemon.py 10003
```

where `10003` is the default port number used by the SSS. The message "`Waiting for connection ...`" that shows on the terminal confirms that the server is correctly set.

Run the following command on "Host B" to start the CPS:

```
% $JTRS/corba/mission_services_server
```

An IOR (interoperatable object reference) appears in the terminal window and a GUI window of system diagram pops up. At the moment being, the naming service has not been implemented. You need to manually pass the IOR to the client side ("Host A"). To do so, on "Host B", run the following commands to copy the IOR file securely to "Host A":

```
% cd $JTRS/corba
```

```
% scp mission_service.ior username@HostA.hostname:$JTRS/corba/
```

Each time you restart the CPS, you need to pass the new mission_service.ior file to "Host A". You may have to explicitly kill the Python processes of the previous server execution, by first finding the PID (process ID number) of python, by typing on terminal

```
% ps
```

then killing the process by typing

```
% kill -9 PID
```

How to Use This User Manual

This user manual consists of two parts. Part I provides a comprehensive explanation of Vimpacct tool. It may be used for thorough understanding of each parts of the tool. Part II is a quick user guide. If the user's expectation is the minimal knowledge just enough to be able to use the tool, the user may directly jump to Part II. The glossary of this manual is provided at the end.

Chapter 2

An Overview of Vimpacct

Key Features

Vimpacct provides tools to help you fully optimize and analyze the energy consumption of mission-oriented embedded systems. The following lists the key features that Vimpacct provides:

- Interpret a high-level mission profile
- Generate a low power schedule
- Simulate schedules via SpecC simulation engine
- Visualize optimal mission power profile
- Interactively play back the power-mode simulation
- Output a comprehensive report that includes power breakdown, component utility, power savings from the baseline scenario, etc.
- Dispatch power commands to a CORBA power server.
- Let the users edit the power model

These capabilities are supported by the back-end programs including IMPACCT scheduler, SpecC simulator, and Command dispatcher.

Part I

User Manual

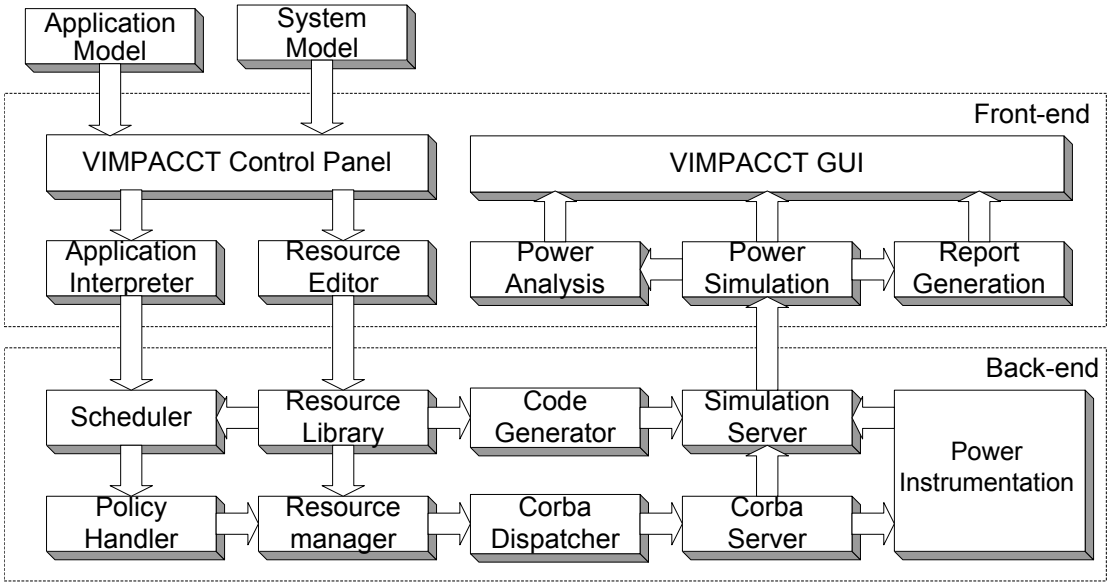


Figure 1: Block Diagram of Vimpacct Tool Flow

1 Tool Flow

Fig. 1 shows the tool flow of Vimpacct. The top-level partition of the functions is input, front-end, and back-end. Here, we explain these blocks following the flow of data.

The input to the tool consists of the Application Model and System Model. Application Model captures the high-level knowledge that is related to mission scenario. System Model captures the architectural information such as the parameters of the hardware resources and dependency among them. Before starting the tool, these inputs need to be captured in files in the format described in the following section.

Through the control panel of the front-end, the inputs are loaded. Application Interpreter interprets the XML model into a schedulable format, and the Resource Editor lets the user add/delete/modify parameters of the System Model.

Then, the back-end of Vimpacct performs scheduling, policy handling and resource management. Scheduler determines the task sequence with exact timestamp; Policy Handler generates mission-aware policies[1]; Resource Manager determines the power modes of each resource. These three functions generate energy-optimal power command trace.

The finalized resource configuration is stored in Resource Library, and passed to Code Generator, where the specC simulation code is generated. The generated power command trace from Resource Manager is dispatched from the CORBA Dispatcher to the CORBA Server. CORBA Server sends the power control both directly to the Simulation Server and via Power Instrumentation Unit, which is used for hardware co-simulation.

The power command trace passed from Simulation Server is simulated, analyzed, and saved in a report format. The result is visualized on Vimpacct GUI, which also allows interactive simulation play-back.

The following sections will explain each of the functions in details, in the following order:

[1]Policy determines the state of the system. For example, (channel_1 ON, channel_2 OFF) can be a system state. A policy can be thought of a *macro mode* of the system, where a *macro mode* consists of one or more component mode(s); ie., (PA1 ON, Modem1 ON, GPS ON, PA2 OFF, ...).

- 1) input (Section 2),
- 2) front-end (Section 3–4),
- 3) back-end (Section 6–7),
- 4) front-end (Section 8–10)

2 Input Format

As Vimpacct uses parameters of both the system and the environment/scenario content, it receives input from both the application model and the system model.

2.1 Application Model

The input of the application model consists of mission configuration, mission profile, and the mission library. Mission configuration is the an XML file that contains the overall mission scenario. By MAPMgen, this configuration turns into a message sequence. Since these mission files contain some exclusive information, both of them are required as Vimpacct input. Mission library also contains exclusive data, those of which not clarified in either configuration nor profile.

XML Mission Configuration

This part is extracted by mapmgen_config.ppt released by Rockwell Collins on 4/14/2003. The mission configuration contains the following elements:

- mission
- comm_manager
- msgprofile

The mission element defines the mission parameters such as start location and time and the sequence of mission phases. The comm_manager element(s) defines parameters that control sending and receiving groups of messages. The msgprofile element defines what messages are used and message profiles that define sets of messages and timing values used during a mission phase. Unless otherwise defined all numeric parameters must be integers. The mapmgen program does not verify the correctness of the configuration before beginning message simulation. If an error occurs during a waypoint Mapm_gen may exit after outputing an incomplete mission. Examples of errors: a waypoint referencing an undefined profile, a msgtiming element using an undefined message opcode, or a profile include element referencing an undefined profile. Below, each of these elements are clearly demonstrated in an XML format.

First, mission is defined by `start` and `phases`.

```
<mission>
     <start>
     <comment>
     Define starting position and time for the mission. Time is in milli-
     seconds. The ticksizemsec is the number of milliseconds the clock
     will advance at a time.  Each time the clock advances the mission
     controller will be notified and will pass the time event to the
     comm_manager(s) in order for them to generate messages.
     </comment>
          <location latitude="42.039" altitude="0" longitude="-91.633" />
          <time start="0" ticksizemsec="100" />
     </start>
```

```
     <comment>
     Define mission phases. The sequence number defines the order in which
     the phases are played. This number must start at 0 and increment by 1.
     No gaps are allowed in the sequence.
     </comment>
     + <phase sequence="0" name="preflight" latitude="42.039" altitude="0"
     longitude="-91.633" duration="20000">
     + <phase sequence="1" name="taxi" latitude="42.039" altitude="0"
     longitude="-91.625" duration="265000">
     + <phase sequence="2" name="to\_theater" latitude="42.539" altitude=
     "5000" longitude="-91.625" duration="571000">
     + <phase sequence="3" name="attack" latitude="42.539" altitude="4000"
     longitude="-91.958" duration="313000">
</mission>
```

`Phases` further expand to the following format.

```
<phase sequence="0" name="preflight" latitude="42.039" altitude="0"
 longitude="-91.633" duration="20000">
     <comment>
     A phase element has attributes defining the destination in
     latitude/longitude/altitude measured in degrees and feet and either
     a duration in msec or a speed in nautical mph. A phase must have at
     least one waypoint. If there are more than one the sequence number
     defines their order in the same manner as described in phase. A
     waypoint has a duration attribute which defines it’s length in msec.
     The last waypoint duration should be 0 and it will last till the end
     of the phase. If the duration total for all waypoints exceeds the
     phase length the phase will terminate according to the information
     in the phase element. If the waypoint total is less and the last
     waypoint does not have a duration of 0 the phase will end when that
     waypoint is reached. There will be an instantaneous jump in location
     to the destination if this occurs.
     </comment>
     <waypoint sequence="0" duration="0">
          <comment>
          Waypoints must contain a msgprofile element and one or more
          waveform elements. The msgprofile element index attribute
          defines the message profile element to use for this segment of
          the mission. Within each phase the msgprofiles are accumulative.
          At the beginning of a phase the list of messages in use is
          cleared. Message timings are then loaded from the profile in the
          first waypoint. For each subsequent waypoint the given profile
          is added to the message timing list, overwriting settings for
          any messages that are currently defined. The waveform attribute
```

```
          indicates which comm_manager will be used for a msgprofile
          and thus which waveform will be used to transmit the messages.
          </comment>
          <msgprofile index=100" waveform=" 0" />
     </waypoint>
</phase>
```

Second, comm_manager is defined in the following format.

```
<comm_manager waveform=0" description="Satcom">
     <comment>
     Describes parameters needed by a communications manager. waveform is
     an integer value that must start with 0 and increment by 1 for each
     additional comm_manager.  waveform is referenced by a msgprofile element
     in a waypoint to indicate which comm_manager is used for the profiles
     group of messages.  The description attribute is a string without
     spaces.  The string is output for each message generated by the
     comm_manager and describes the waveform used to transmit the message.
     request_interval is the time differential between sending groups of
     request messages. The round_trip_delay defines how long after a request
     group is sent before the associated response is received. Both
     parameters are defined in milliseconds. After a request group is sent
     the system will not send another until the response is received.
     </comment>
     <time request_interval="1500" round_trip_delay="1000" />
</comm_manager>
```

Third, msg profile is defined by `messages` and `profile indices`.

```
<msgprofile>
     <comment>
     The msgprofile element must include one and only one 'messages' element
     and one or more 'profile' elements.
     </comment>
     + <messages>
     + <profile index="100">
     + <profile index="101">
     + <profile index="200">
     + <profile index="201">
     + <profile index="212">
</msgprofile>
```

`Messages` further expand to the following format.

```
<messages>
     <comment>
     All messages are described here. Required attributes for a message are
```

```
      opcode, type, size, and family. opcode is a 3 digit hex integer with
      leading 0's. size is a decimal integer. family is a decimal integer
      describing what class the message belongs in. type may be one of these
      string values: request, response, or broadcast. A broadcast message
      is one that the UCAV sends to the ground without being requested. All
      other messages must be defined in request/response pairs. request
      message must include a 'reply' attribute that defines the opcode of
      the response message. Response messages may include an optional 'gps'
      attribute. If this attribute is set to 1 then location coordinates
      will be included on the log line whenever the message is sent. The
      order which the message elements appear is not important.
      </comment>
      <message opcode="001" type="request" size="0" reply="801" family="8" />
      <message opcode="801" type="response" size="2" family="8" />
      <message opcode="003" type="request" size="0" reply="803" family="8" />
      <message opcode="803" type="response" size="0" family="8" />
      <message opcode="010" type="request" size="0" reply="810" family="2" />
      <message opcode="810" type="response" size="16" gps="1" family="2" />
</messages>
```

`Profiles` further expand to the following format.

```
<profile index="100">
      <comment>
      The profile element contains subelements that define the messages that
      are in use during a waypoint leg and the timing parameters used when
      sending those messages. Each profile element must include an index
      attribute with a unique integer value. This attribute is referenced by
      the msgprofile element which is part of a waypoint. The index attribute
      must be an integer, but there is no requirement that these numbers be in
      order, and the list of profile numbers can contain missing values.
      Subelements in a profile can be one of two types: include and msgtiming.
      There can be any number of either type of element included. The
      msgtiming element defines attributes that control how many of and how
      often messages with the given opcode are sent. The interval attribute
      defines the time between requests in msec. The repeat attribute is how
      many times this message will be sent in a given mission phase. If the
      interval is 0 the message will not be sent at all. The include element
      must contain two attributes, sequence and index. index references
      another profile element. The sequence attribute controls the order in
      which the include elements are processed. When a waypoint defines a
      profile, that profile element is read in. The system processes the
      include elements first and then the msgtiming elements. The result of an
      include element being processed is the same as inserting the contents of
      the profile it references into the current profile. This include process
```

```
    is recursive, so if the included profile contains include elements, then
    those profiles are added as well. Note that there is no checking for
    infinite loops, so care must be used when creating an include hierarchy
    that has several levels. After the include elements are processed the
    system will read the msgtiming elements. The result is that the
    msgtiming elements in the current profile will overwrite msgtiming
    elements contained in the included profiles. This allows the mission
    designer to include a general profile and override particular message
    types in this derived profile.
    </comment>
    <include sequence="0" index="1000" />
    <msgtiming opcode="142" interval="1" repeat="1" />
    <msgtiming opcode="01f" interval="1" repeat="1" />
</profile>
```

Mission Profile (.txt)

Mapm_gen interprets the XML configuration and generates output in the following format:

```
timestamp  waveform  opcode  w  x  latitude  longitude  altitude  y  z
```

The latitude, longitude, and altitude information appears only with a specific opcode, and `w, x, y, z` are the parameters not utilized by Vimpacct. The following is an example mission profile.

```
0.000   Link16   21a   2   2
0.100   Link16   342   6   4
0.100   Link16   346   8   2
0.100   Link16   351   4   2
0.100   Link16   510   32  2   0.305463 -0.338655 0 985097.5683 47.9507
0.100   Link16   3b7   4   1
0.100   Link16   501   6   8
```

Mission Library (.py)

Mission Library is currently required to be configured manually, although there is a default file for the demo purpose. It includes:

- Waveform configuration
- Delay for a channel to process a message
- Location of the objects (base station, satellite, and other JTRS objects)

We demonstrate the format in the following sample file.

```
waveform = {
'Link16':  {'freq':1000, 'opband':'hb', 'ch': 1, 'type': 'p2p'},
'Satcom':  {'freq':225, 'opband':'lb', 'ch': 2, 'type': 'sat1'},
```

```
'ATC':     {'freq':30, 'opband':'lb', 'ch': 3, 'type': 'base'},
'MilStar': {'freq':30, 'opband':'lb', 'ch': 4, 'type': 'sat2'}
}

# average time to process a message thru a channel (in sec)
TIMEPERMSG = 0.001

# location of basestation (in degrees, km)
base_la = 42.039
base_al = 0
base_lo = -91.633

# location of satellites (in degrees, km)
sat1_la = 23.0
sat1_al = 35000
sat1_lo = 58.6

sat2_la = 25.5
sat2_al = 38000
sat2_lo = 52.5

# location of other JTRS system
def object_loc(time):
import math
la =  30+0.000001*time
al = 1000+10*math.sin(time*math.pi/720)
lo = 55+0.000001*time
return la, al, lo
```

Although we assume the location of the other JTRS system as a function over time for now, a mechanism provided by the communication protocol will enable the system to track the real location.

2.2 System Model

System Model consists of

- Components
- Modes
- Transitions
- Macro
- PowerSupply
- Dependency

Components

Components include list of the entire power manageable[2] hardware resources in the system and their short name as shown in following example.

```
Components= {
       'md': 'Modem',
       'ts': 'Transciever',
       'pa': 'Power Amplifier',...
}
```

Modes

Modes specify the power mode of each components, each mode having for parameters: *metric*, *tag*, *power*, *para*. *Metric* specifies the application specific information, ie., transmission power of PA for required level of SNR (Signal-to-Noise Ratio). *Tag* specifies the active/idle type of mode. *Power* specifies the actual power consumption level of the mode considering the efficiency of the real hardware. *Para* specifies the ideal power consumption level of the mode. Below shows an example.

```
Modes= {'md': {'ON': {'metric': '-', 'tag': 'idle', 'power': 4.0, 'para': '-'},
               'OFF':{'metric': '-', 'tag': 'idle', 'power': 0.01, 'para': '-'},
               'STB': {'metric': '-', 'tag': 'idle', 'power': 1.0, 'para': '-'}}
        'ts': {'ON': {'metric': '-', 'tag': 'idle', 'power': 25.0, 'para': '-'},
               'OFF':{'metric': '-', 'tag': 'idle', 'power': 0.01, 'para': '-'},
        'STB':{'metric': '-', 'tag': 'idle', 'power': 0.1, para': '-'}},
        'pa': {'RX': {'metric': 6.99, 'tag': 'idle', 'power': 5, 'para': 5.0 },
               'OFF':{'metric': -20.0, 'tag': 'idle', 'power': 0.01, 'para': 0.01},
               'STB': {'metric': 0.0, 'tag': 'idle', 'power': 1.0, 'para': 1.0},
               'TL1':  {'metric': 9.4, 'tag': 'idle', 'power': 8.7, 'para': 1.0},
               'TL2':  {'metric': 16.23, 'tag': 'idle', 'power': 42, 'para': 10.0},
               'TL3':  {'metric': 25.71, 'tag': 'idle', 'power': 372, 'para': 100.0},
               'TH1':  {'metric': 9.4, 'tag': 'idle', 'power': 8.7, 'para': 1.0},
               'TH2':  {'metric': 16.23, 'tag': 'idle', 'power': 42, 'para': 10.0},
               'BYP': {'metric': 7.3, 'tag': 'idle', 'power': 5.37, 'para': 0.1}},
         ...
}
```

Transitions

Transitions specify the mode transition overhead. Similar to Modes, *power* and *para* is defined, and *time* specifies the worst case delay of the transition. Below shows an example. Note that *para* is an optional field.

```
Transitions = {
         'md': {'STB_OFF': {'power': 1.0, 'para': '-', 'time': 0},
                'ON_STB': {'power': 4.0, 'para': '-', 'time': 100},
```

[2]more than one power mode

```
                'ON_OFF': {'power': 4.0, 'para': '-', 'time': 0},
                'STB_ON': {'power': 2.5, 'para': '-', 'time': 0.1},
                'OFF_ON': {'power': '4.0', 'para': '-', 'time': '50'},
                'OFF_STB': {'power': '4.0', 'para': '-', 'time': '50'}},
        'ts': {'STB_OFF': {'power': 0.1, 'para': '-', 'time': 0},
                'ON_STB': {'power': 25.0, 'para': '-', 'time': 100},
                'ON_OFF': {'power': 25.0, 'para': '-', 'time': 0},
                'STB_ON': {'power': 12.5, 'para': '-', 'time': 0.1},
                'OFF_ON': {'power': '25.0', 'para': '-', 'time': '50'},
                'OFF_STB': {'power': '25.0', 'para': '-', 'time': '50'}},
        ...
}
```

Macro

Macro specifies the power consumption of macro modes. Each macro mode is given a name, such as 'MAIN' in the below example, and have the consisting components listed, with the formula for calculating the macro power consumptions.

```
Macro = {  'MAIN'       : (['dc', 'gu', 'bi'], 'dc+gu+bi'),
           'MAIN/0.85'  : (['dc', 'gu', 'bi'], '(dc+gu+bi)/0.85'),
           'MAIN/0.7': (['dc', 'gu', 'bi'], '(dc+gu+bi)/0.7'),
           'BLK'  : (['ts', 'md', 'bp'], 'ts+md+bp'),
           'BLK/0.9': (['ts', 'md', 'bp'], '(ts+md+bp)/0.9'),
           'RED'  : (['ri', 'rp', 'eu'], 'ri+rp+eu'),
           'RED/0.9': (['ri', 'rp', 'eu'], '(ri+rp+eu)/0.9')  }
```

PowerSupply

PowerSupply specifies the formula to calculate the power consumption of the power supply components, as shown as below.

```
PowerSupply = { 'bw': {'ON':'BLK/0.9'},
                'rw': {'ON':'RED/0.9'},
                'mw': {'ON':'MAIN/0.85', 'STB':'MAIN/0.7'}  }
```

Dependency

Dependency specifies the mode constraints among the components. A mode dependency follows one of the following two formats:

```
c0.m0: [c1.m1, ' ']
c0.m0: [c1.m1, c2.m2, op]
```

where $c_i, m_i, i = 0, 1, 2$ represents a component and a power mode, respectively. The mode dependency is used to check whether $c0.m0$ is a valid mode setting. The first statement says $c0$ is in $m0$ only if $c1$ is in

$m1$. In other words, if $c1$ is not in $m1$, $c0$ cannot be in $m0$. The second statement says $c0$ is in $m0$ only if $c1.m1$ op $c2.m2$ is true. $c_i.m_i$ is true if the component c_i is in the mode m_i. op is a logical operator among AND, OR, XOR. See the below example. The first constraint says "The PA is on only if the domain controller is on and main power is on". The last constraint says "The domain controller is on only if the main power is on".

```
Dependency = {  'pa.ON': ['dc.ON','mw.ON','&'],
                'ts.ON': ['dc.ON','bw.ON','&'],
                'bp.ON': ['dc.ON','bw.ON','&'],
                'dc.ON': ['mw.ON',' '] }
```

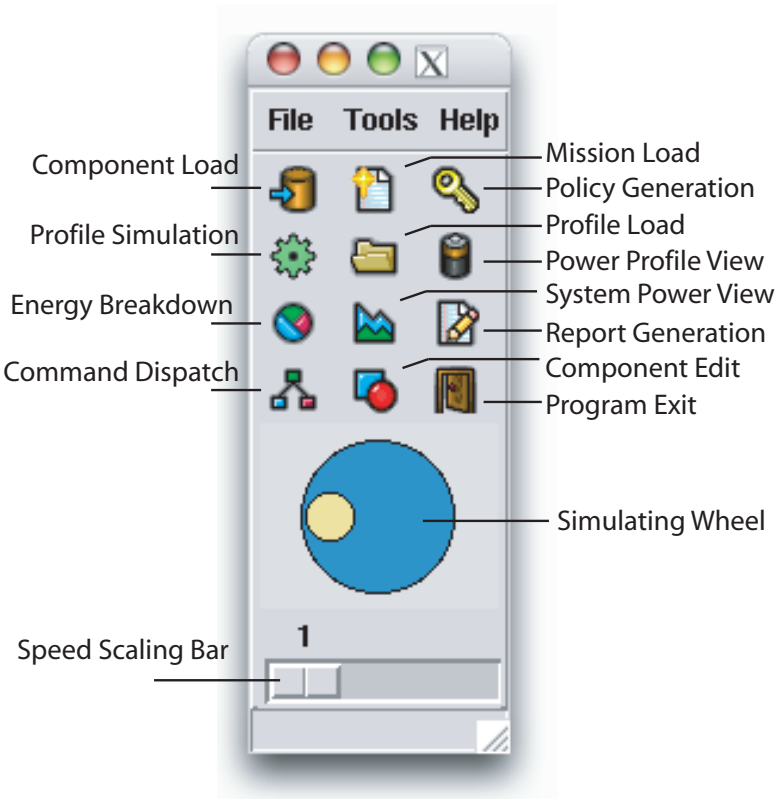


Figure 2: Conrol Panel

3 Control Panel

Control Panel shown in Fig. 2 is used for running each function of Vimpacct. Table 1 shows the mapping of icon to menu, and their brief description. The rows are presented in the order of the usage (tool flow).

In the users point of view, C1–C3 are used for loading the inputs, C4,C5,C10,C11 are used for running the tools, and C6–C9 are used for viewing the results. The simulating wheel and the scaling bar are used in controlling the user-interactive simulation play back, which will be explained in Section 8. Complete explanation for each control functions will be presented in Section 5–10.

	Icon	File Menu	Descryption
C1		File→Load Library	Load the component library, ie., `mycomplib.py`
C2		File→Load Mission	Load the component library, ie., `mission7.txt`
C3		File→Load Profile	Load a pre-simulated mission (optional)
C4		Tools→Policy Generation	Generate power control commands.
C5		Tools→Profile Simulation	Run the simulation
C6		Tools→Display Component Power	View the channel/component power profile
C7		Tools→Display Energy Profile	View the energy breakdown
C8		Tools→Display System Power	View the system power profile
C9		Tools→Generate Report	Generate the summary report
C10		Tools→Run Dispatcher	Run the CORBA client dispatcher
C11		Tools→Edit	Open the component editor
C12		File→Exit	Exit the Program

Table 1: Control Panel Functions

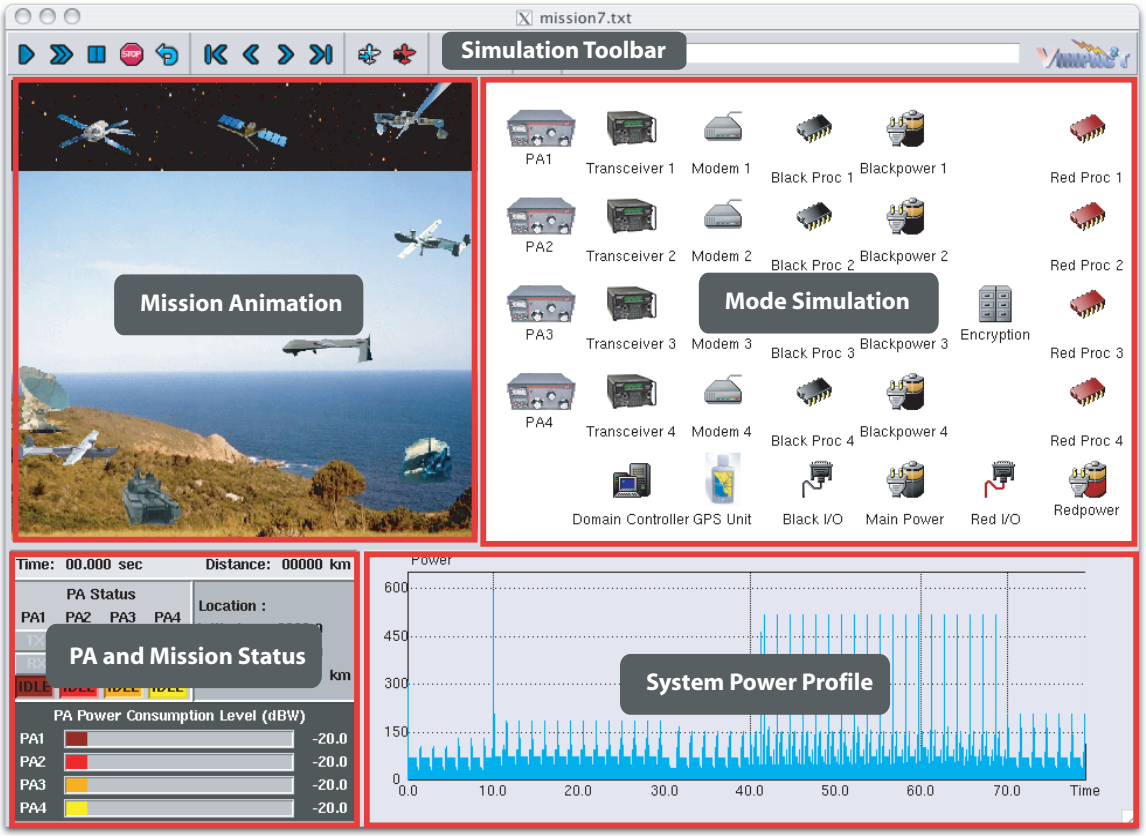


Figure 3: Main Window of Vimpacct Tool

4 Main Window

Fig. 3 shows the main window of Vimpacct. It consists of Simulation Toolbar on top, and four frames that consist of Mission Animation, Mode Simulation, PA and Mission Status, and System Power Profile. These frames are tightly coupled. In other words, change of status in one frame applies changes in all other frames also. This window is utilized for visualizing the simulation, and thus, is related to the interactive play back (rather than back-end auto-simulation), which will be explained thoroughly in Section 8. Here, we briefly introduce their usages.

Simulation Toolbar that consist of 11 control icons is used for controlling the interactive simulation play back.

Mission Animation frame shows the high-level scenario view of a mission. The background consists of four possible places of the communicating objects: land, sky, water, and space. The communicating objects are base stations, JTRS objects (possibly UAVs, ships, and tanks), and satellites. During the simulation play back, these objects animate to show their location, distance, and the communication activities.

Mode Simulation frame shows the layout of the system architecture. In this window, all the power manageable hardware components are displayed, and they change color during the simulation play back. Different colors specify the power mode of the components.

PA and Mission Status frame consists of four sub-frames: top, middle-left, middle-right, and bottom. The top frame shows the elapsed time counted from the beginning of simulation, and the current communica-

tion distance. The middle-left frame shows the status of each PAs among TX/RX/IDLE. The middle-right frame shows the current location of the main JTRS object (our system). The bottom frame shows the power consumption level of PA in terms of dBW.

System Power Profile displays the entire simulation profile, with Y-axis as system power (Watt) and X-axis as time (sec). It lets the user analyze the system status at the peak power usages.

5 Component Editor

The Component Editor is a user front-end for the component library. The User can use the Component Editor to create/edit component models which are then compiled into simulatable SpecC models for power simulation.

The Component Editor allows the user to

- Create a component library
- Add/remove components to a component library
- Change the component ID and the component description of a component
- Add/remove power modes of a component
- Change the name and attributes of a power mode
- Add/remove mode transitions of a component
- Change the name and attributes of a mode transition
- Generate the SpecC model of a component library[3]

The main window of the Component Editor has three columns. The left column allows the user to edit the component list of a library. The middle column allows the user to edit the power modes of a component. The right column allows the user to edit the mode transitions of a component. We will first briefly introduce the menu functions, followed by the descriptions of the functions in each column.

5.1 Menu functions

File→New Library...	Create a new library. Save the currently opened library if it is modified.
File→Open a Library...	Open an existing library. Save the currently opened library if it is modified.
File→Save	Save the current library.
File→Save As...	Save the current library with a specified name.
File→Close	Close the current library. Save it if modified.
File→Exit	Exit the window.
Tool→SpecC Code Gen...	Code generation of the SpecC power model.
About→Help	Empty stub.

5.2 Editing the Component List

The left column of the main window has a list window to show the component list. Once a library is loaded, the component ID's and names are listed. The component ID is a short name of a component without a space. The component name is an elaborated name the user defined for the component.

[3] A SpecC compiler v1.2 or higher is required; a GCC compiler v2.9x is required.

Add a component[4]	Type in the component ID in the short empty field. Type in the component name in the long empty field. Click the Add button below the short empty field.
Edit a component	Click a component name. Type in the updated information. Click the Edit button below the long empty field.
Remove a component	Click a component name. Click the Remove button below the long empty field.

5.3 Editing Power Modes

Double-click a component name in the left column brings up the available power modes and mode transitions of the component in the middle and right columns, respectively. The middle column allows the user to edit the power modes of a component. There are four attributes of a power mode:

- Mode name
- Power Consumption
- Parameter
- Metric

The Power Name must be in capital letters without spaces. The Power Consumption can be either a number (integer or floating-point), or a formula. The Parameter is used as a variable when the Power Consumption is represented as a formula. The Metric is application-specific, representing an application-level requirement or constraint,e.g., quality of service, signal to noise ratio, etc..

Add a mode	Type in ALL the four attributes in the corresponding fields (use hyphen if it is empty). Click the Add button at the bottom of the column.
Edit a mode	Check a mode name. Type in the updated information. Click the Edit button at the bottom of the column.
Remove a mode	Click a mode name. Click the Remove button at the bottom of the column.

5.4 Editing Mode Transitions

Double-click a component name in the left column brings up the available power modes and mode transitions of the component in the middle and right columns, respectively. The right column allows the user to edit the mode transitions of a component. There are five attributes of a mode transition:

- From mode
- To mode
- Time
- Power

- Parameter

The From mode and To mode are two power modes of a mode transition, as the name suggested. The Time and Power are the time delay and the power consumption of the mode transition, respectively. The Parameter is used as a variable when either or both of the Time and Power attributes are represented as a formula.

Add a mode transition	Type in ALL the five attributes in the corresponding fields (use hyphen if it is empty). Click the Add button at the bottom of the column.
Edit a mode transition	Check a From mode name. Type in the updated information. Click the Edit button at the bottom of the column.
Remove a mode transition	Click a From mode name. Click the Remove button at the bottom of the column.

6 Policy Generation and Simulation

Vimpacct policy generation is based on Decoupled Power Management Architecture(DOMA). The main idea is to decouple system-level policy making from the architectural level device control. For more information on the DPMA, please refer to [**?**].

Vimpacct mission simulation is performed using SpecC power models. The advantage of using SpecC power models is the powerful support for concurrent simulation and sychronized communication between software modules.

6.1 Preparing the input files

To run the poligy generation, the user need to prepare the mission profile files and the component library file.

Put the mission profiles both in the XML format and in the text format (generated by MAPMgen.exe) in $JTRS/missionlib/. Some sample files are already in there. Refer to the sample files for the file format.

Put the component library in $JTRS/complib/. The component library is a Python script. Users familiar with Python language can manually edit the library file, Refer to $JTRS/complib/mycomplib.py as an example. General users can use the GUI (Component Editor) to create/edit a component library without knowing Python.

6.2 Start Running

When the user starts the policy generation, some text messages are printing on the terminal window showing the progress of the policy generation. Depending on the size of the mission, the policy generation may take a while. When it shows “Mode transitions generated by DPMA”, the process is completed.

Once the policy generation is completed, the mission simulation can be started. The power commands are sent to the SpecC simulation Server for power simulation. Some text messages are printed out on both the client side and the server side. Once the mission simulation is done, the system power profile appears on the Main Display Window.

7 Power Command Dispatch

We can send the generated power commands to a virtual platform for execution. The CORBA is used as the common interface between the power manager and the virtual platform.

The CORBA server is written in C++, with a Python wrapper that interacts with a graphic user interface as the virtual platform. The server receives the power commands of individual components from the client, execute the commands on the server and displays the power mode changes on the graphic user interface.

The CORBA client is written in Python. It reads a static power schedule from a file in which each power command is associated with a time stamp. The commands are dispatched at the real time through the CORBA interface to the server.

The CORBA client identifies the server by the means of the Interoperatable Object Reference (IOR) which is produced on the server side once the server is started. Therefore the IOR should be sent to the client prior to its dispatch of power commands.

To start the CORBA server, type the following commands in a terminal on the server host:

```
%cd $JTRS/corba
```

```
% python py_mission_server.py
```

To send the IOR to the client side, run the following commands in a separate terminal on the server host:

```
% cd $JTRS/corba
```

```
% scp mission_service.ior username@client.host.name:$JTRS/corba/
```

where `client.host.name` is the host name on the client side and `username` is the user account name on the client side. Jiwon: is this correct? ('name' in the address?)

To start the command dispatch on the client side, choose Tools→Run Dispatcher or click on the Control Panel. You will see text messages printing to the shell windows on both server side and client side. At the same time, the commands are executed on the virtual platform on the server side and power modes transitions are shown in the graphic window on the server side.

The command dispatch is completed when it reaches the end of the power schedule.

To shut down the CORBA server, the user need to explicitly identify and kill the server process.

```
% ps -ef | grep python
```

```
% kill -9 serverProcessNumber
```

where `serverProcessNumber` is the process number of the server process.

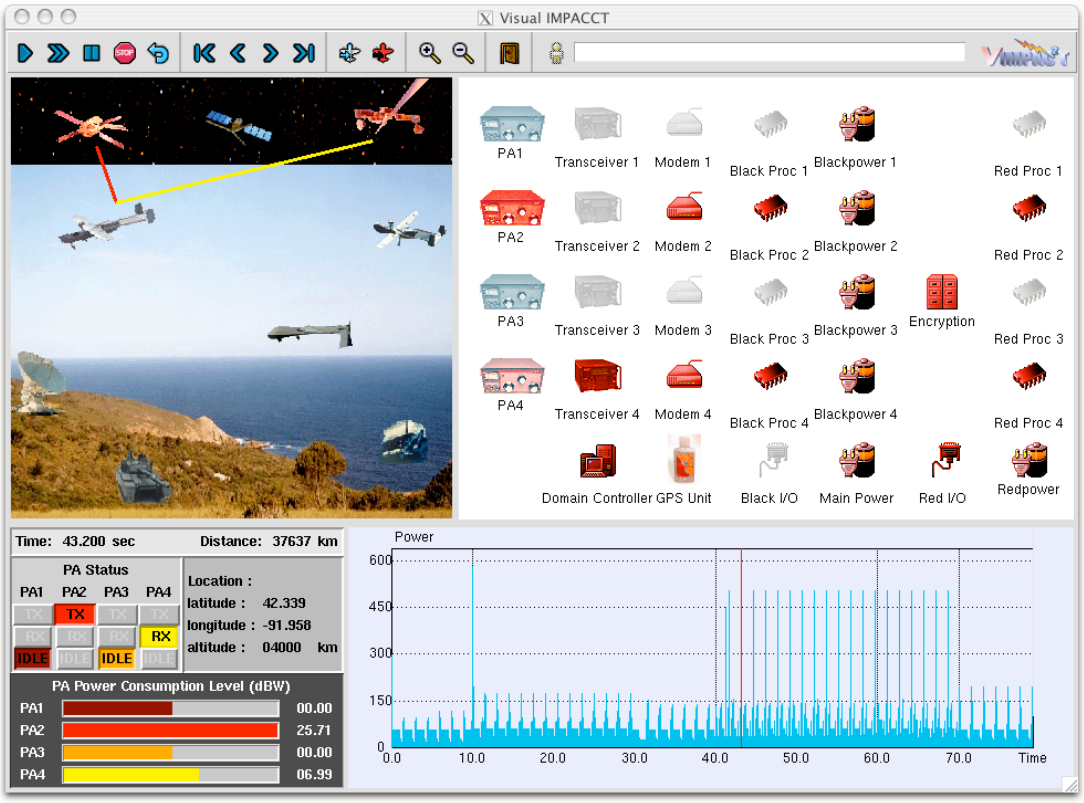
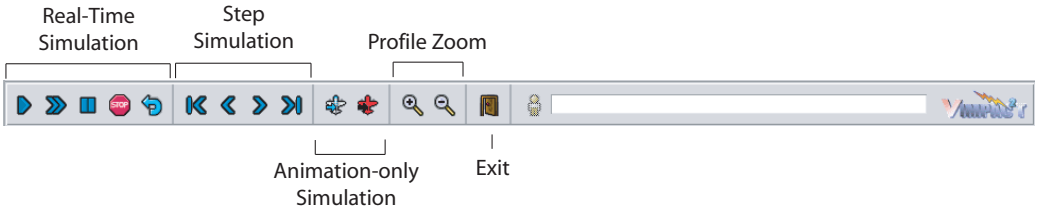


Figure 4: The Main Window Display during Playback

8 Interactive Simulation Playback

Interactive Simulation Playback allows the user to observe the simulation in controlled granularity. The play back is controlled by the toolbar on top of the main window as shown below, and the simulating wheel on the control panel (Fig. 1).



We will first explain how to interpret the main window display during the play back, then explain the usage of each group of controls.

8.1 Main Window During the Play Back

Fig. 4 shows the main display window during the simulation playback. As introduced in Section 4, it shows the mission animation, mode simulation, PA and mission status, and system power profile frame inside the quadrant.

In the Mission Animation frame, shown in Fig. 5, the JTRS object moves during the mission, and the

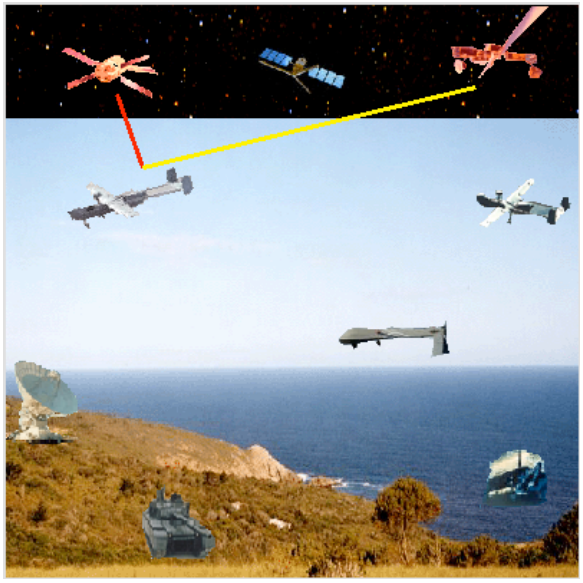


Figure 5: Mission Animation during Playback

communication links appears in colored lines. Each color (dark red, red, orange, and yellow) indicates one channel among four. When the link is accomplished, the communicating objects turns into red.

The Mode Simulation frame, shown in Fig. 6 shows the system architecture. When the simulation is initialized, each components show their original colors. During the simulation, they switch colors showing their mode status. *Gray* indicates OFF mode, *blue* indicates IDLE mode, *light pink* indicates RX mode (in PA only), and *red* indicates FULL ON mode.

The PA and Mission Status during Playback frame shown in Fig. 7 shows the time, communicating distance, PA status, location, and the power consumption level of PA. On this example, the elapsed time is 43.2 sec, the distance between active link (where the PA is transmitting message) is 37637 km. PA1[5] and PA3 are in IDLE[6] mode, PA2 is in TX mode, and PA4 is in RX mode. The current location of our JTRS system is displayed in latitude, longitude (in degrees), and altitude (in km). We can see that PA2 power level bar has reached the maximum amount, since it is transmitting to a far distance.

The System Power Profile frame shows the profile of the system through the entire mission as shown in Fig. 8. This particular mission has the interval of approximately 80 sec. The red anchor line proceeds to the right while the simulation plays.

8.2 Real-Time Simulation

Real-time simulation lets the user play back a mission at the speed of real time. The user can start, fast forward, pause, stop, and reset the mission. At any time, the user may either jump forward or backward onto any timestamp of a mission by clicking on a desired point on the power profile window. For example, if the user clicks on a point around 40.0 sec as shown on the top of Fig. 9, the anchor (red line) will move to that point, and all four frames will display the mission status at 40.0 sec.

[5] PA for channel 1

[6] IDLE/ACTIVE for the PA is determined by whether message is going through the PA or not. ACTIVE includes RX (receiving) or TX (transmitting) mode.

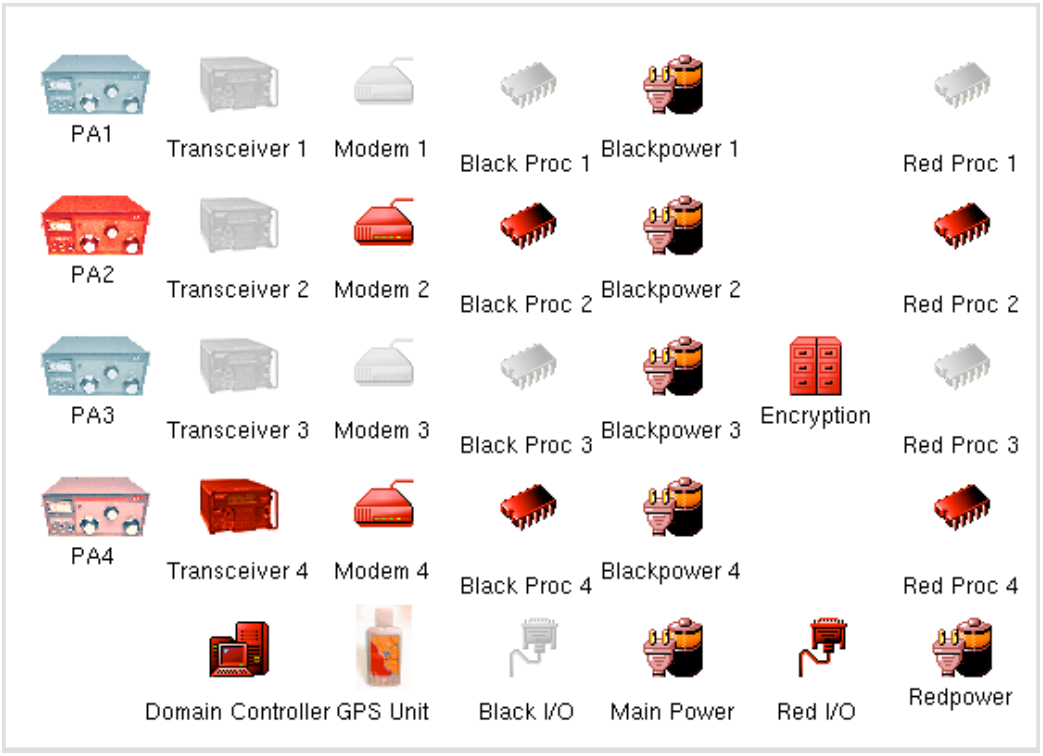


Figure 6: Mode Simulation during Playback

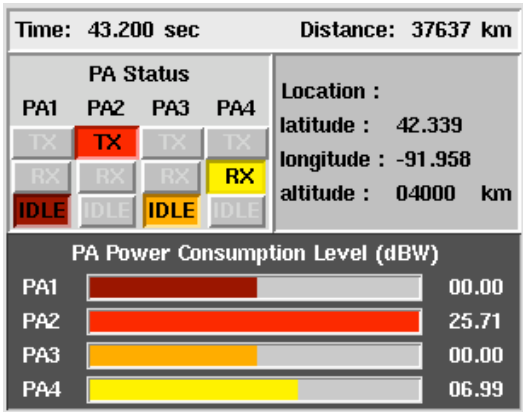


Figure 7: PA and Mission Status during Playback

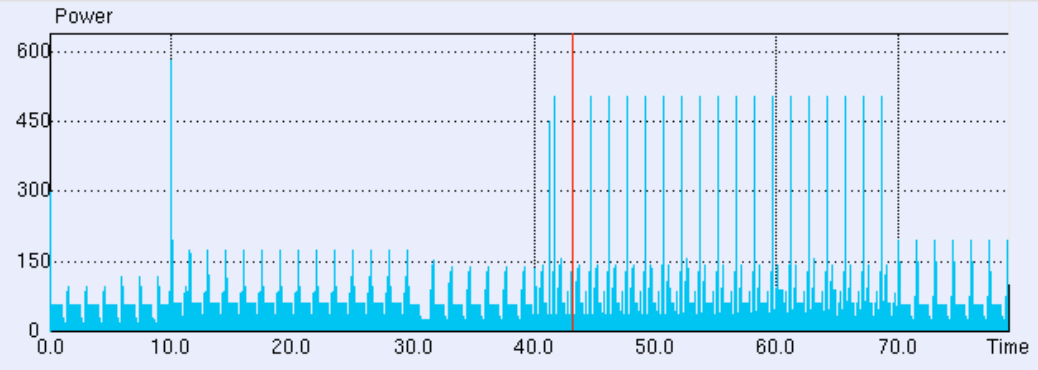


Figure 8: System Power Profile during Playback

The following table shows the description of the real-time simulation control.

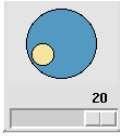
Icon	Description
	Play-back the mission on real-time
	Fast-forward the mission
	Pause the real-time play-back
	Stop a real-time play-back
	Return to initial state of the mission

8.3 Step Simulation

The user can also play step simulation to observe the states in finer grain. The below controls support step simulation.

Icon	Description
	Go to the beginning state of a mission
	Step backward to the previous state of a mission
	Step forward to the next state of a mission
	Go to the final state of a mission

Alternatively, the user may use the Simulation Wheel, on the control panel:



The user can first set the speed of the wheel, by controlling the scale bar, where 1 represents the fastest speed and 20, the slowest speed. Then, the user manually rolls the wheel either clockwise or counter clockwise to proceed the simulation or roll-back the simulation, respectively (see Fig. 10).

Figure 9: Setting the Anchor Point

Figure 10: Manual Simulation by Rolling the Simulating Wheel

8.4 Animation-only Simulation

Animation-only simulation lets you observe the mission scenario at a glance. Independent of system power mode, it proceeds the simulation in a rapid speed – faster than fast forward function of real-time simulation. This functionality is controlled by the following two icons.

Icon	Description
	Run the animation of a mission only (fast)
	Stop the animation of a mission only

8.5 Zoom I/O

Zoom functions let the user observe the system mode in multi-granular way. Since the time granularity of the mode transitions is in milliseconds, and the mission length can reach longer than 10 hours, the zoom in/out is an important functionality. It is controlled either by clicking the below icons, or directly selecting an area by mouse on the power profile frame.

Icon	Description
	Zoom in one step of the system power profile
	Zoom out one step of the system power profile

Here, we show the usage of these functions by an example. Fig. 11 is an initial state after a mission load. On the power profile, it is observed that there is a power glitch around timestamp of 10 sec. To discover the exact system state that is causing the glitch, the user may click and drag the mouse to select the area to zoom in (see Fig. 12). The user can repeat zooming in until the desired view is reached. In Fig. 12, the original

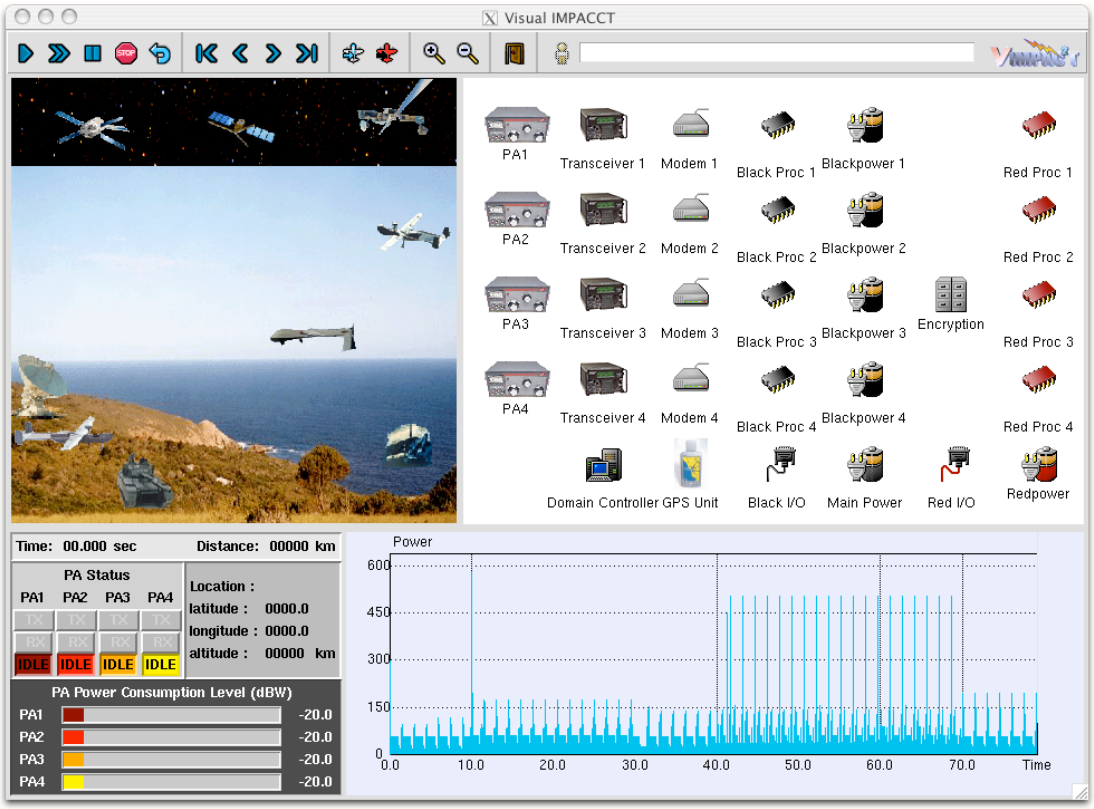


Figure 11: Initial State after Loading the Mission

profile is zoomed in three times. Then, the user can click on a point (10.101 sec) to exactly set the anchor.

Fig. 13 shows the global view of the main window. Now, the user can see the reason why there seemed to be a power glitch; 1) there are many communication activities going on at the moment with three PAs on active power states, 2) more than half of the system is fully ON. Without zooming in, it is hard for the user to set the anchor to the exact point where this state occurs.

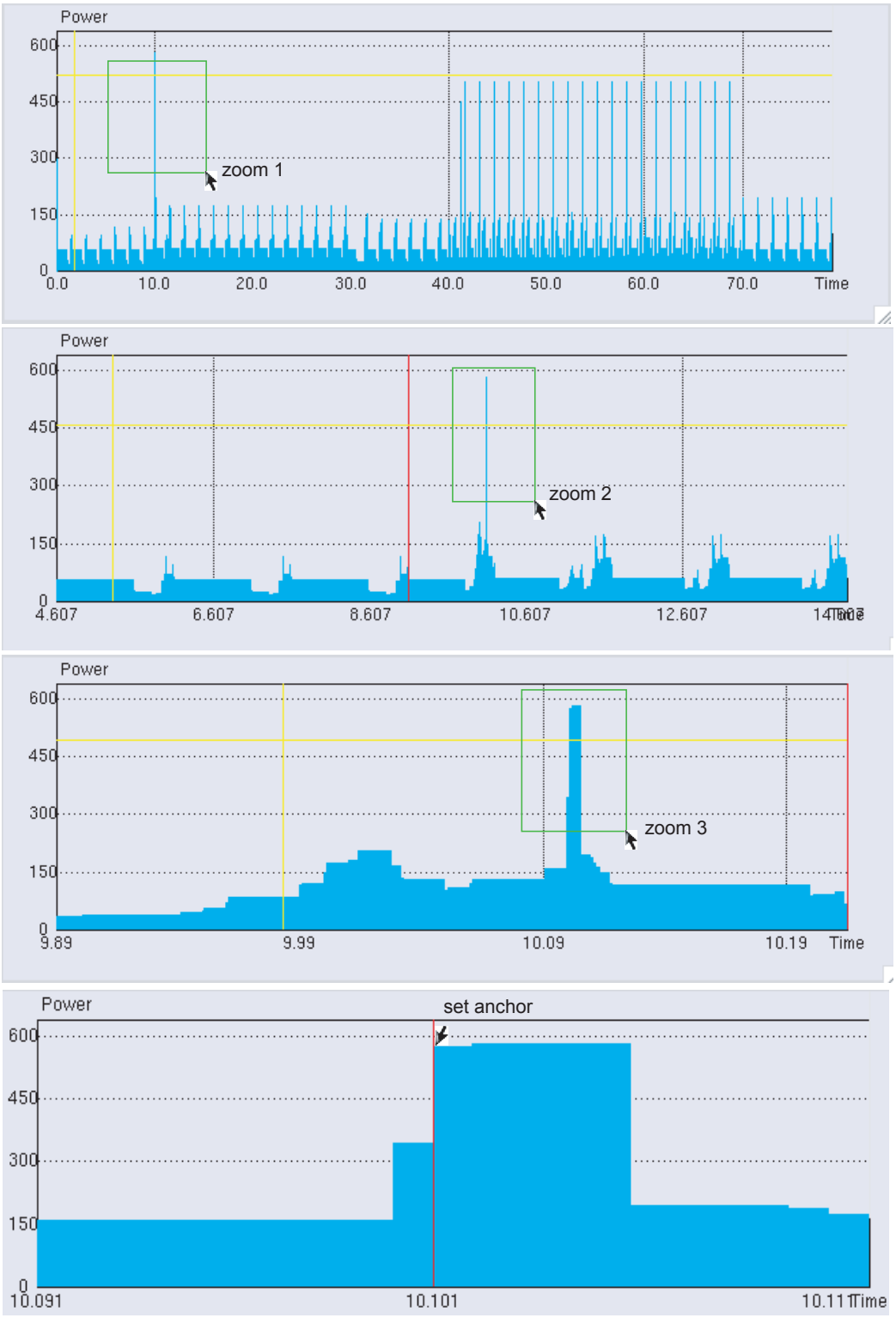


Figure 12: The Usage of Zoom In

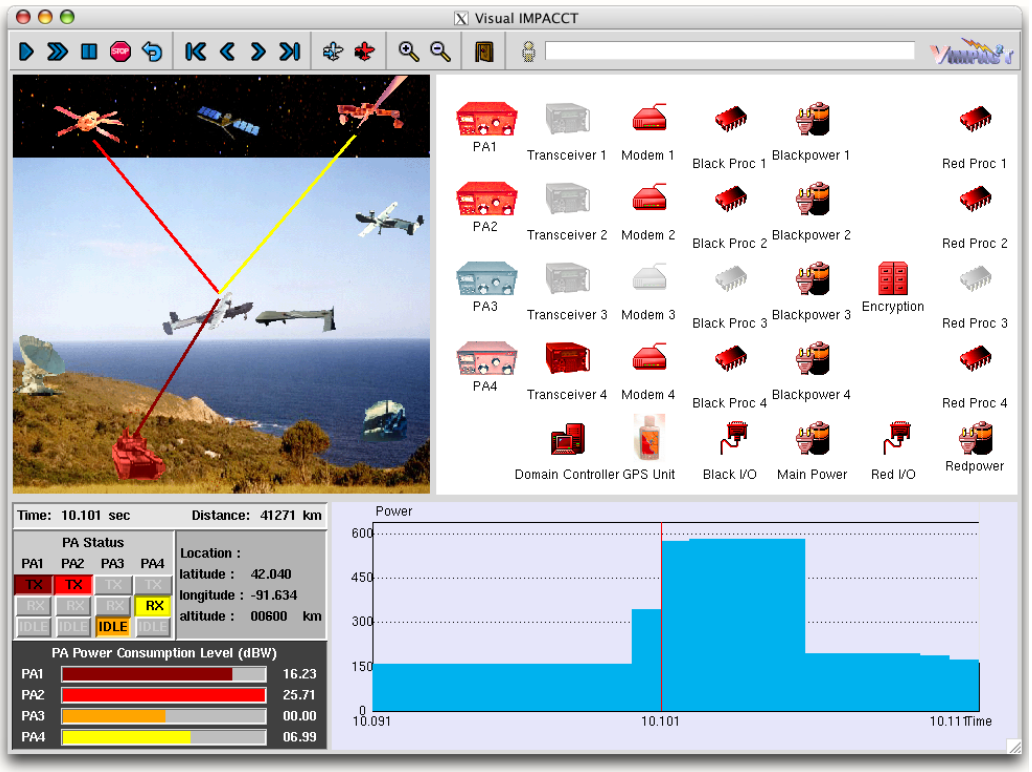


Figure 13: The Result of Fig. 12

9 Power Analysis

Once the mission simulation is completed, the information about power break-down of channels as well as that of components are available for analysis.

9.1 Power profile

To obtain the power profiles, choose Tools→Select Component Power or click on the Control Panel.

A new window of channel-level power profiles shows up, each track representing the power profile of a channel. The user can zoom in or zoom out the power profile by clicking the corresponding buttons at the top of the window. The user can double-click a track to view a lower level (component-level) of power profiles.

	View more details of the profiles
	View less details of the profiles
	Generate an EPS file of the window
	Exit the window

9.2 Pie Chart

To obtain the pie charts, choose Tools→Display Profile menu item or click on the Control Panel.

The pie chart shows the power break-down of the system by channels. Double-click each portion in the energy pie chart to view each channel's energy break-down by components.

The user can choose to export the power profiles or pie charts to EPS files by clicking .

10 Report Generation

The user can use the report generation tool to generate customized text reports and figures.

10.1 Report Features

Start the report generation tool by choosing Tools→Generate Report or click on the Control Panel (col 3, row 3).

The user can generate the following items in the text report:

- General mission information
- Channel-level energy information
- Component-level energy information
- Channel-level command information
- Component-level command information

The user can set the sorting criteria for the energy information:

- by channel
- by component name
- by energy usage
- by time usage

The user can set the sorting criteria for the command information:

- by channel
- by component name
- by command count

The user can generate the following figures in the encapsulate postscript EPS format:

- System power profile
- Channel-level power profile
- Component-level power profile
- System-level pie chart
- Channel-level pie chart

The user can save the text report by clicking the Save button. To load a previously stored text report, click Load button. The EPS figures are stored at `$JTRS/report/eps` directory.

10.2 Report Format

Here is the description of the fields in the report.

General	
Mission Name	The name of the mission
Mission Length	The length of the mission in seconds
Total No. of messages	Number of messages in the input mission profile
Total No. of commands	Number of power commands generated by the tool
Total waveforms	total number of waveforms
Total channels	total number of channels
Total components	total number of power-manageable components
System peak power	Peak power consumption over the mission, in Watt
Total energy	Total energy after power management, in Joule
Baseline Energy	Energy consumption without power management, in Joule
Energy savings	Energy savings in percentage
Channel-level energy statistics	
Channel	Channel number (0 is shared resources)
Energy	Energy consumption of the channle, in Joule
Percentage	Energy percentage of the channel
Component-level energy statistics	
Component Name	Component description
Energy(J)	Energy consumption of the component, in Joule
Energy(%)	Energy percentage of the component, in percentage
Ontime(s)	Time in which component has non-zero workload, in second
Ontime(%)	Time percentage of Ontime, in percentage
Channel-level command statistics	
Channel	Channel number (0 is shared resources)
Command(#)	Number of commands for that channel
Command(%)	Percentage of the number of commands
Component-level command statistics	
Component Name	Component description
Command(#)	Number of commands for that component
Command(%)	Percentage of the number of commands

Part II

Quick User Guide

This quick user guide contains the following subsections:

- Getting started
- Using the tools
- Viewing the results
- Generating reports
- Executing power commands
- Editing components
- Interactively playing back the simulation
- Debugging the tool at run-time

11 Getting Started

To get started, you first need to prepare the input files: mission files (mission configuration and mission profile), and component library. Mission profile is pre-generated by passing mission configuration through MAPMgen. Put the mission filesin $JTRS/missionlib/. For the demo purpose, some sample files already exists. Refer to the sample files to get the file format. Let us assume the mission to be executed is "mission7", so we place `mission7.xml` and `mission7.txt` in $JTRS/missionlib/ directory. Put the component library in $JTRS/complib/. The component library is a Python script. Users familiar with Python can manually edit a library file. Users may use the GUI (Component Editor) to create/edit a component library without knowing Python. For the demo purpose, the component library `mycomplib.py` is already in there.

Now we can run Vimpacct by entering the directory and run the main script as following.

```
% cd $JTRS/jtrsgui/code/
```

```
% python jtrsgui.py
```

As a quick Vimpacct splash disappears, the Control Panel (the small window on the left) and the Main Display Window (the large window on the right) show up (see Fig. 14). Main Display Window consists of a simulation toolbar on the top, and four frames underneath that display:

- Mission Animation
- Mode Simulation
- PA and Mission Status
- System Power Profile

Fig. 15 shows the icons of the control panel that are used to speed up access to the tools. The following subsections will reveal the functionalities of the corresponding tools.

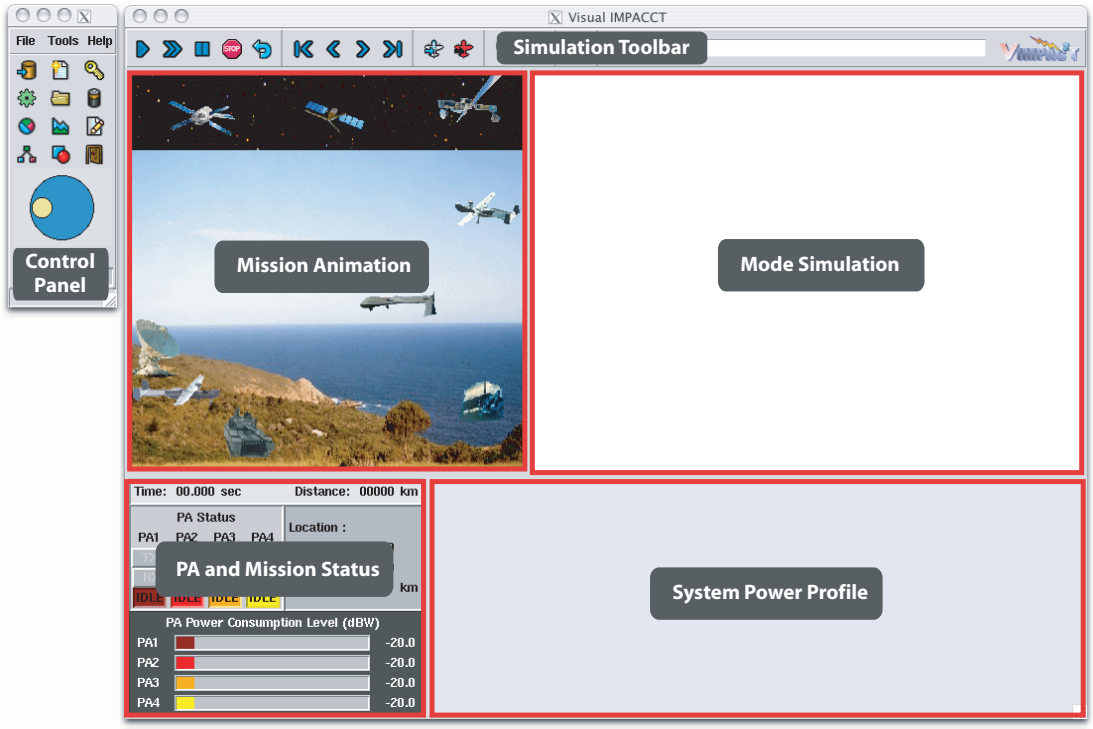


Figure 14: GUI: the Control Panel and the Main Display Window.

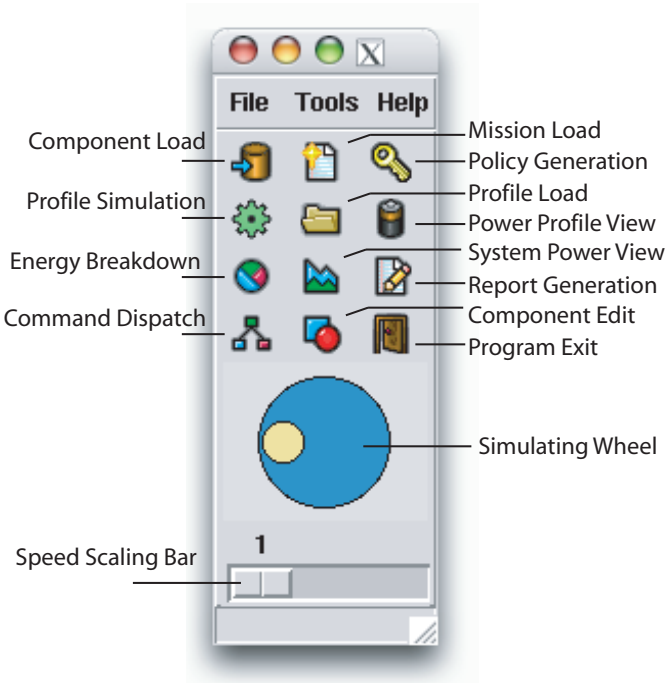


Figure 15: Control Panel

12 Using the tools

Vimpacct offers various tools for optimizing, simulating, and analyzing energy consumption of a mission. We will explain these tools in the sequential order, which let you explore full functionality of Vimpacct.

12.1 Simulating Mission

This subsection shows the sequence of using the tools related to the auto-simulation of a mission. By following the steps shown in Table 2, you can simulate/load/save a mission.

Step	Icon	File Menu	Explanation
1		File→Load Library	Load the component library, ie., `mycomplib.py`
2		File→Load Mission	Load the component library, ie., `mission7.txt` To find the library, you should navigate to $JTRS/missionlib
3		Tools→Policy Generation	Generate power control commands. Depending on the size of the mission, this may take a while.
4		Tools→Profile Simulation	Run the simulation; on completion, the system components and the system power profile will appear on the Main Window (Fig. 16)
5	–	File→Save Profile	Save the simulation result as a user-defined name for later use
6		File→Load Profile	Load a pre-simulated mission

Table 2: Steps for Mission Simulation.

In the meanwhile, you can check the progress in the terminal window in which you started the GUI. For example, when the process of Step 3 is completed, you will see a terminal message, “Mode transitions generated by DPMA”. Please make sure the previous process is finished, before executing the next step. The simulated power profile is generated after Step 4, and saved as “result.txt” as default, in $JTRS/.temp.

12.2 Viewing Results

The result of simulation is energy analysis of the optimized system for the mission. It could be observed in two different ways: system power profile in 2D energy/time graph and energy breakdown in pie charts. Both ways offer multi-level analysis, by letting users choose to zoom into channel-level view, and zoom out to system-level view.

The below table shows how to view the results.

Icon	File Menu	Description
	Tools→Display System Power	View the system power profile
	Tools→Display Component Power	View the channel/component power profile
	Tools→Display Energy Profile	View the energy breakdown

Table 3: Two Ways to Observe the Optimized Energy

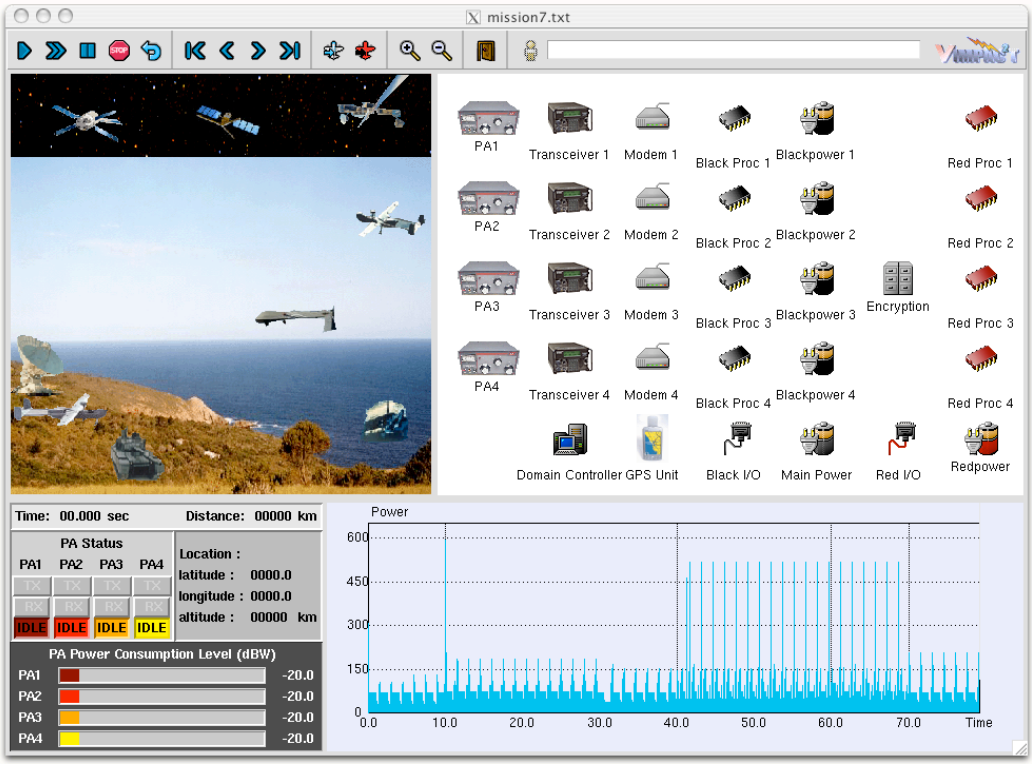


Figure 16: Main Window with System Components and Power Profile Loaded

System Power Profile View

By selecting the first icon/menu in Table 3, a system view of power profile pops up as shown in Fig. 17 (a).

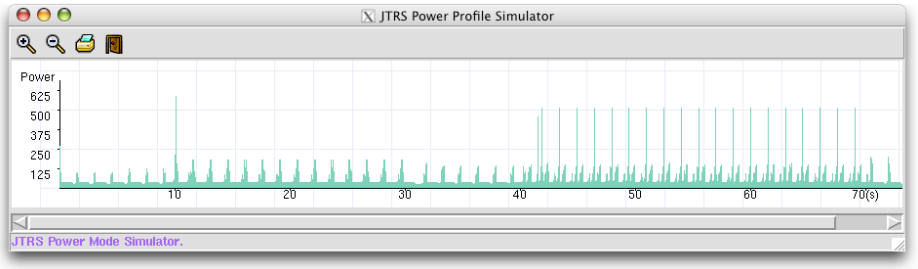
Channel/Component Power Profile View

The second icon/menu in Table 3 will instantiate a new window entitled “JTRS Power Profile Simulator” as shown in Fig. 17 (b). This is the profile view of the channels. By double clicking a blue area of a channel, another window will pop up, showing the detail component power of the channel as shown in Fig. 17 (c). In these window, there are four icons on the top. The following table shows the usage of each.

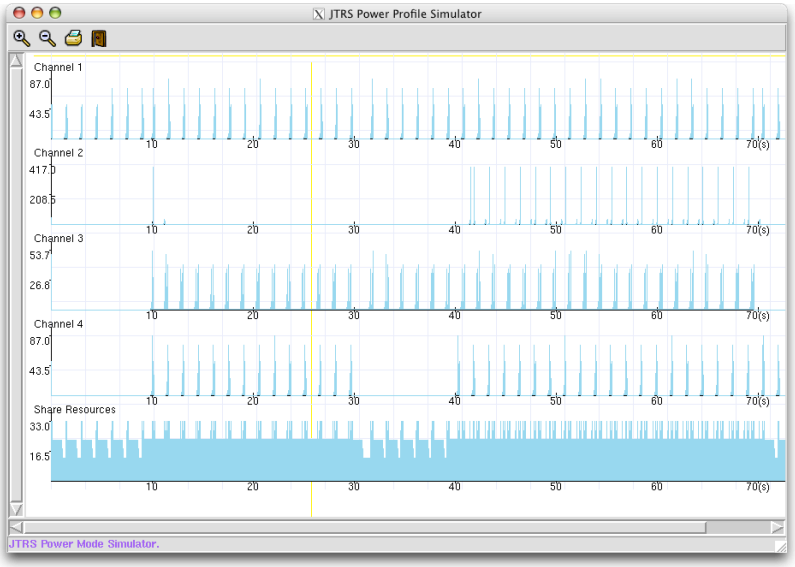
Icon	Description
	Zoom in the power profile within the same system/component level
	Zoom out the power profile within the same system/component level
	Export the displayed power profiles to an EPS file
	Close the window

Energy Breakdown View

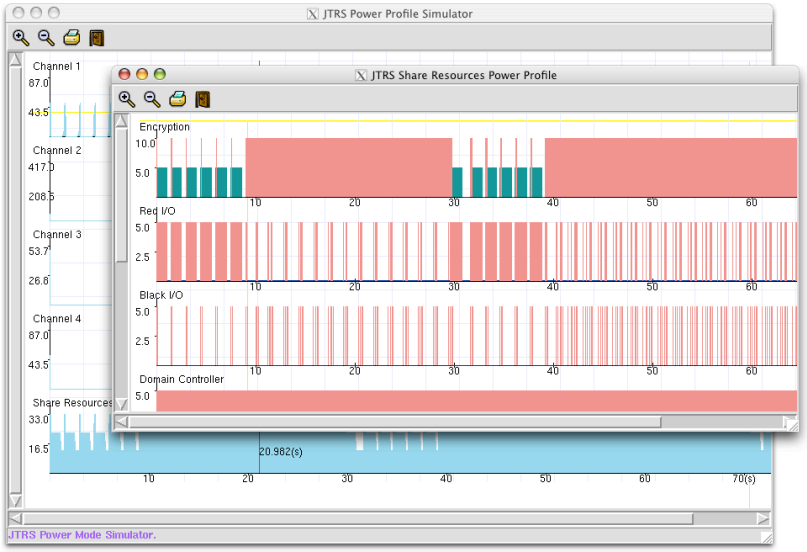
By clicking the third icon/menu of Table 3, a window showing a pie chart of system power breakdown will pop up. Double-click each portion in the energy pie chart to view the energy breakdown of a lower level, as shown in Fig. 18.



(a) System View



(b) Channel View



(c) Component View

Figure 17: Multi-Level View of Simulated Power Profiles. (c) is observed by double-clicking on (b).

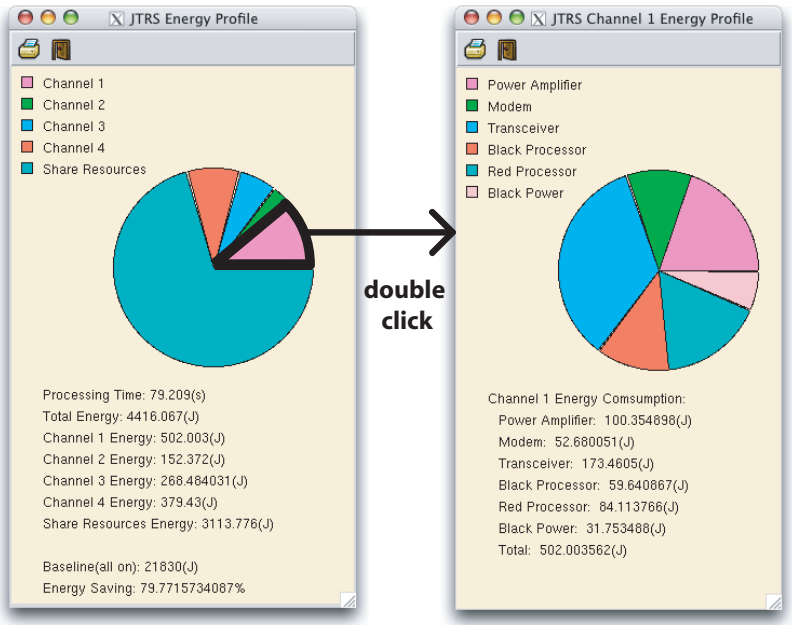


Figure 18: Pie charts: Energy breakdown. Double-click a slice to navigate a level down.

12.3 Generating Report

Icon	File Menu
	Tools→Generate Report

Comment: dexin, I don't see "Tools→Generate Report" on the Tools menu right now. is it included in the latest version?

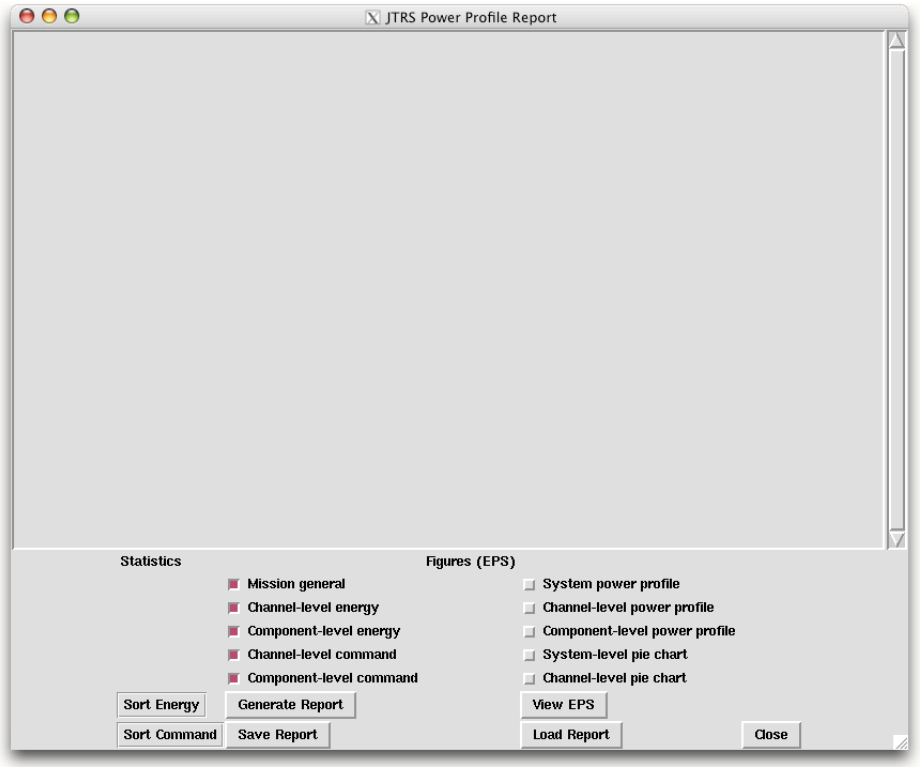
By the above icon or menu, you can generate a report of the simulation profile A new window will pop up and you can specify the items you want to generate in the report by selecting or deselecting the checkboxes (see Fig. 19 (a)). You can specify the sorting criteria by selecting the pull-down menu at the bottom of the window (Fig. 19 (b), (c)). The default is set to sort by channel. When the selection is done, click "Generate Report" button to generate the report in the main text window. The generated report will look like Fig. 20. You can save the report by clicking the "Save Report" button. You can load a previously stored report by clicking Load button. After done, close the window.

12.4 Executing Power Commands

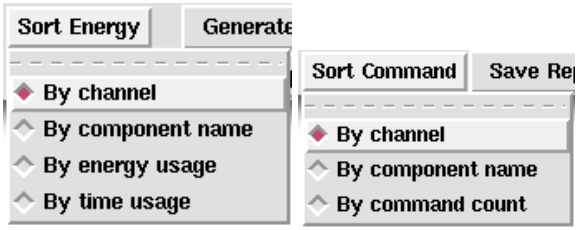
Now you can run the Command Dispatcher to send the power commands to the CORBA Power Server through a CORBA interface. Click on the below icon or menu to run the CORBA client.

Icon	File Menu
	Tools→Run Dispatcher

You will see text messages printing to the shell windows on both server side and client slide hosts as shown in Fig. 21. At the same time, the commands are executed on the virtual platform on "Host B" and power modes transitions are shown in the server-side GUI.



(a)



(b) (c)

Figure 19: Generating report. (a) is the main text window. (b) shows the option list of sorting the energy. (c) shows the option list of sorting the command.

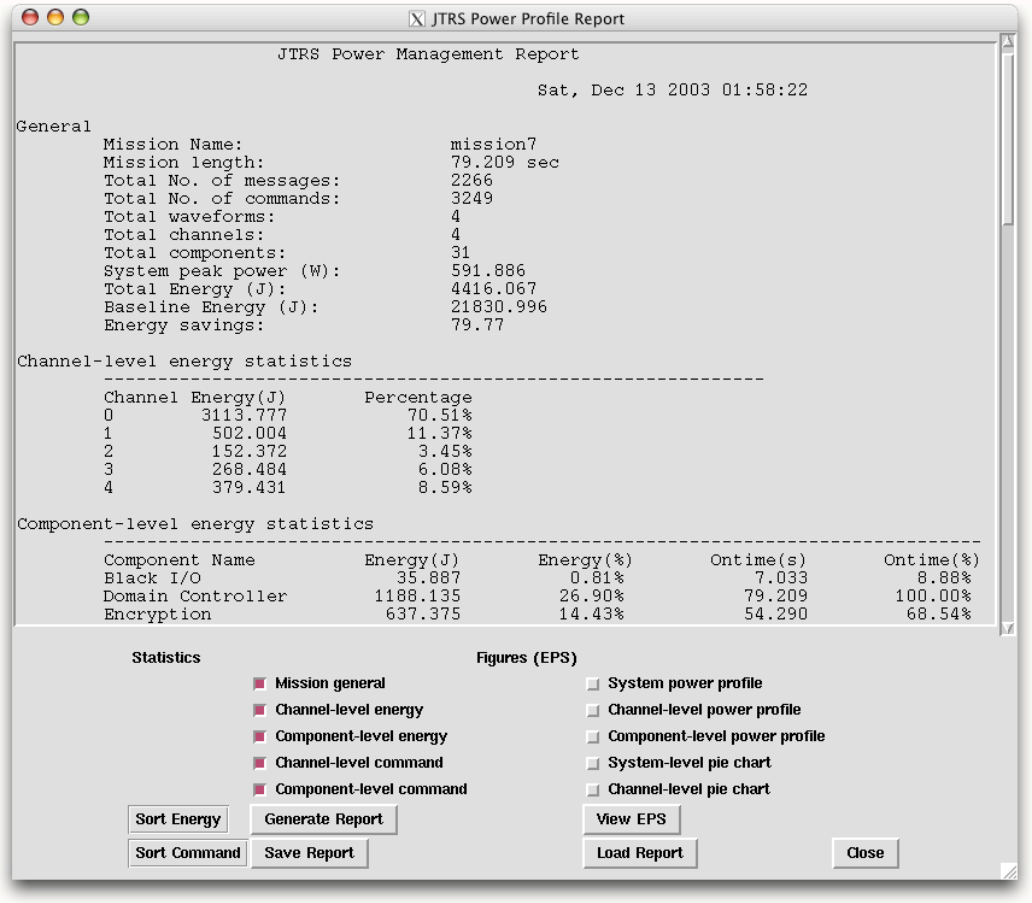


Figure 20: The Generated Report

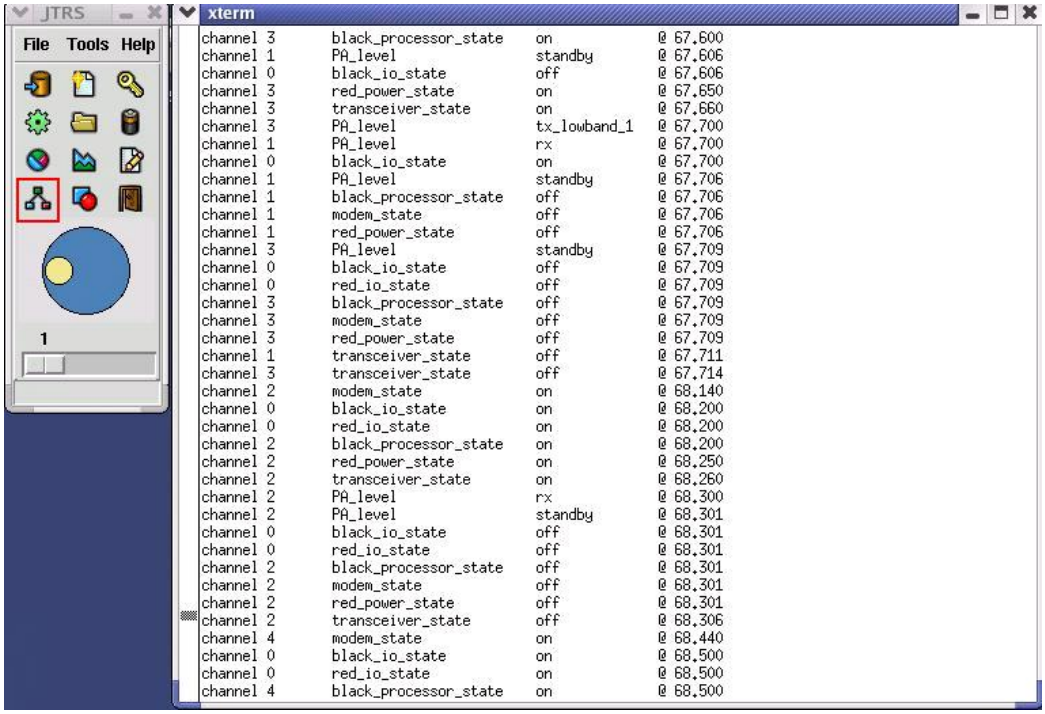

JTRS
File Tools Help
1
xterm
channel 3 black_processor_state on @ 67.600
channel 1 PA_level standby @ 67.606
channel 0 black_io_state off @ 67.606
channel 3 red_power_state on @ 67.650
channel 3 transceiver_state on @ 67.660
channel 3 PA_level tx_lowband_1 @ 67.700
channel 1 PA_level rx @ 67.700
channel 0 black_io_state on @ 67.700
channel 1 PA_level standby @ 67.706
channel 1 black_processor_state off @ 67.706
channel 1 modem_state off @ 67.706
channel 1 red_power_state off @ 67.706
channel 3 PA_level standby @ 67.709
channel 0 black_io_state off @ 67.709
channel 0 red_io_state off @ 67.709
channel 3 black_processor_state off @ 67.709
channel 3 modem_state off @ 67.709
channel 3 red_power_state off @ 67.709
channel 1 transceiver_state off @ 67.711
channel 3 transceiver_state off @ 67.714
channel 2 modem_state on @ 68.140
channel 0 black_io_state on @ 68.200
channel 0 red_io_state on @ 68.200
channel 2 black_processor_state on @ 68.200
channel 2 red_power_state on @ 68.250
channel 2 transceiver_state on @ 68.260
channel 2 PA_level rx @ 68.300
channel 2 PA_level standby @ 68.301
channel 0 black_io_state off @ 68.301
channel 0 red_io_state off @ 68.301
channel 2 black_processor_state off @ 68.301
channel 2 modem_state off @ 68.301
channel 2 red_power_state off @ 68.301
channel 2 transceiver_state off @ 68.306
channel 4 modem_state on @ 68.440
channel 0 black_io_state on @ 68.500
channel 0 red_io_state on @ 68.500
channel 4 black_processor_state on @ 68.500

Figure 21: Executing power commands through a CORBA client.

12.5 Editing Components

You can simulate the system architecture with different parameters by modifying attributes of components. If you are familiar with Python, directly editing the component library file in a text editor may be easier and faster. The Component Editor provides a graphical interface for general users (see Fig. 22). To open the Component Editor use the below icon or menu.

Icon	File Menu
	Tools→Edit

A new window pops up and all the components are listed in the Component List box on the left side. Double-click a component and its power modes, and mode transition information will show up in the middle and right frames. You can then edit a mode by selecting an existing mode, changing the field you want to modify, and click the edit button. You can also add a mode by filling in the fields and click the add button. Similarly, you can add and edit mode transition information (see Fig. 22). After editing the components, you can save the component library by choosing File→Save or File→ Save As. [7]

12.6 Interactively Playing Back Simulation

Now, let us go back to the main display window (Fig. 14). You will find the following toolbar on the top of the window.

[7] A code generation process needs to be executed to provide the updated power model for the simulation server. To perform the code generation, a SpecC compiler v1.2 or higher and a GCC compiler v2.9x are required.

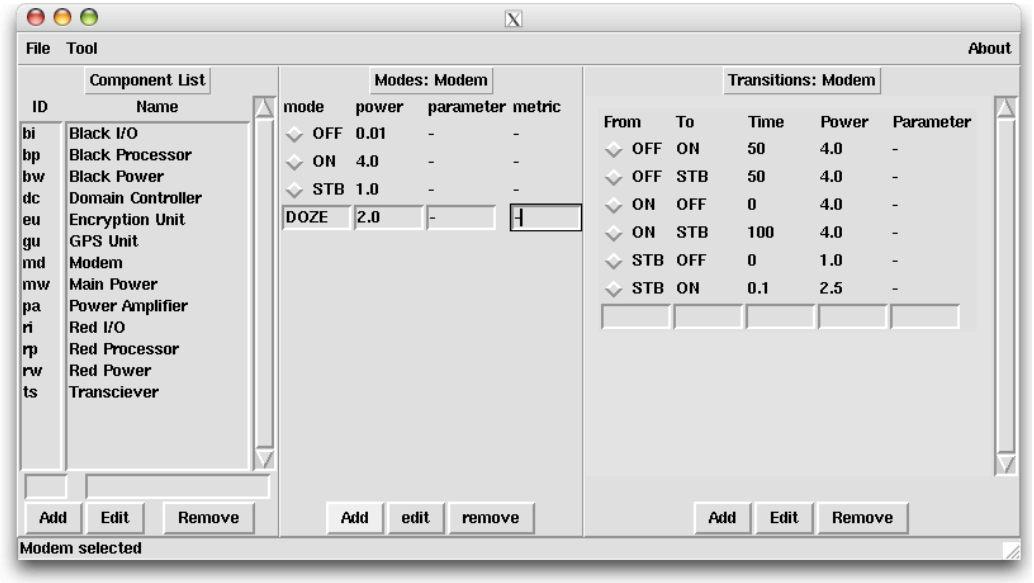
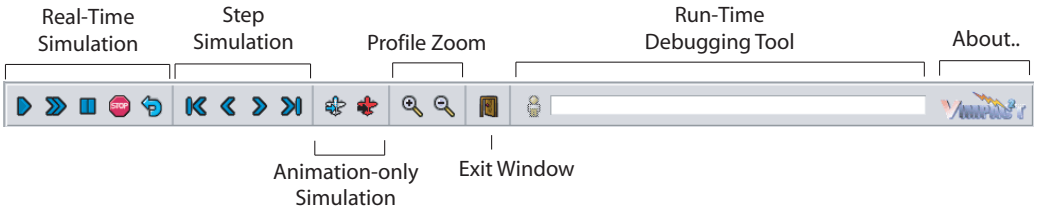


Figure 22: Component Editor.



These tools are used for interactive play-back of a simulation. They are separated in groups that have different functionalities.

Real-Time Simulation

Real-Time Simulation provides a way to simulate the play-back at the speed of the real time. Although it proceeds automatically once simulation is initiated, you have the control to pause/stop and restart the simulation. You may also speed up by the usage of fast forward. You can also reset the simulation. The following table summarizes the functions.

Icon	Description
	Play-back the mission on real-time
	Fast-forward the mission
	Pause the real-time play-back
	Stop a real-time play-back
	Return to initial state of the mission

Step Simulation

The step simulation allows you to observe the detailed mode transition of each component with respect to time. It also provides the high-level view of a mission by the time-accurate animation of communicating objects and the status of time, location, distance, and a mission-aware component (PA). Step simulation is controlled by the following icons.

Icon	Description
	Go to the beginning state of a mission
	Step backward to the previous state of a mission
	Step forward to the next state of a mission
	Go to the final state of a mission

Alternative to these controls, you can also use the simulating wheel on the Control Panel (Fig. 15) to manually playback the mission scenario. You can tune the slowdown factor by setting the scale bar underneath where 1 represents the fastest speed and 20 the slowest speed.

During the simulation, you can set a starting anchor anywhere inside the system power profile frame by clicking at the position you want to start the playback.

Animation-only Simulation

Animation-only simulation lets you observe the mission scenario at a glance. Independent of system power mode, it proceeds the simulation in a rapid speed – faster than fast forward function of real-time simulation. This functionality is controlled by the following two icons.

Icon	Description
	Run the animation of a mission only (fast)
	Stop the animation of a mission only

Etc.

Zoom functions on the main window let you observe into more depth. They work in the bottom right window that shows system power profile.

Icon	Description
	Zoom in one step of the system power profile
	Zoom out one step of the system power profile
	Exit the main display window

12.7 Debugging the Tool at Run-Time

The text entry box in the toolbar of the main window lets the user dynamically modify the program. This box is used by the authors for the debugging purpose. However, if the user is familiar with Python and the Vimpacct code, he/she can also use it to modify the internal variables as well as the GUI itself.

Glossary

CPS	CORBA Power Server
dBW	decibel referenced to one watt
IOR	Interoperatable Object Reference
IMPACCT scheduler	??
MAPMgen	Mission profile generator developed by Rockwell Collins
Mission Configuration	A mission scenario specified by start time, phases, waveforms, message indices, etc, captured in a pre-defined XML format
Mission Profile	A trace of messages ordered by timestamp, which specifies the released time of a message.
Power Model	??
SSS	SpecC Simulation Server
Terminal	The system shell
UCAV	Unmanned Combat Airborne Vehicle

Bibliography